PAT June, 2020; 16 (1): 94 -103 ISSN: 0794-5213
Online copy available at www.patnsukjournal.net/currentissue
Publication of Nasarawa State University, Keffi

Effect of Seed Size on Germination and Early Seedling Growth of *Dennettia tripetala* (G. Baker)

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Abstact
This study was carried out to determine the effect of seed size on germination and early seedling growth of Dennettia tripetala. Three seed size classes: small (Diameter range = 4.04 - 5.88 mm; Length range = 9.14 - 11.07mm); medium (Diameter range = 6.00 - 7.01 mm; Length range = 11.63 - 12.96 mm); and large (Diameter range = 7.03 - 8.10 mm; Length range = 13.05 - 15.21 mm), were used for the experiment which was laid out in a Completely Randomized Design (CRD) with four replicates per seed size class. Evaluation of early seedling growth was based on height, collar diameter, leaf number and biomass. Observation on seedling growth performance commenced two months after sowing and continued monthly thereafter for another three months. Results showed that small seed size had the earliest germination (plumule) emergence (21 days) followed by medium seed size (22 days) and large seed size (24 days). Germination duration ranged from 7 days (large seed size) to 8.25 days (small seed size) and did not vary significantly (p > 0.05) among the three seed sizes. Germination percentage ranged from 71% (large seed size) to 74% (small seed size). The large seed size had better growth characteristics in terms of seedling height, collar diameter, and biomass, than the medium and small seed sizes, with the small seed size showing the least growth potential. No significant difference (p > 0.05) was observed in number of leaves among the three seed size classes. The large seed size class is recommended for the propagation of D. tripetala as its seedlings have the potential to reach maturity earlier than those of the medium and small seed size classes.
Keywords: *Dennettia tripetala, seed size, germination, seedling growth, moisture content*

Introduction

The forests provide a variety of products and services which have great benefit to man. Like other natural resources, forests are unevenly distributed and vary greatly in their potentials and usefulness from country to country (Steinlin, 1982). Natural forest is a complex ecosystem which consists of tree species of great diversity with different uses (Offiong *et al.,* 2010). Such uses and products products which range from timber to non-timber resources include woods, nuts, seeds, fruits, spices, medicines, oil and animals.

Dennettia tripetala also known as Pepper fruit which belongs to the family Annonaceae, is an indigenous spicy medicinal plant in Nigeria that has been cultivated for a long time. Its presence in the Nigeria tropical rainforest and Savanna areas (sometimes) has been reported by Okwu *et al.* (2005). It is widely distributed geographically and consumed by many including the Western Cameroonians, Ivorians and Southern Nigerians (Hutchinson and Dalziel, 1954; Okiy, 1960). The fruits of *Dennettia tripetala* are quite popular in Southern Nigeria where it serves for cultural entertainment of guests, particularly during coronation, the new yam festival and marriage ceremonies (Okigbo, 1980). The fruits are sometimes taken with kola nut, garden egg and palm-wine in some parts of Nigeria (Umoh, 1999). *Dennettia tripetala* fruits have been reported to contain important nutritive substances such as vitamins, minerals and fibre of essential oil (Okwu *et al.,* 2005). The fruits, leaves, bark and root of the plant possess strong peppery and pungent taste (Bassey *et. al.,* 2018). *Dennettia tripetala* fruit serves as mild stimulant to the consumer (Aiyeloja and Bello, 2006). Its various parts are commonly used as spices and condiment (Oyemitan *et al.,* 2008). *D. tripetala* has been reported to have remediation potentials in crude oil contaminated sites (Agbogidi *et al.,* 2006). Seeds of *D. tripetala* also possess insecticidal properties and are used as an effective insecticide in grain protection against weevils in particular (Adedire, 2001).

The seed is of paramount importance in plant production due to its immense influence on the success or failure of both artificial or natural regeneration and the fact that artificial and natural regeneration start with it (Nwoboshi, 1982). The importance of seed size in predicting germination and seedling growth rates both in nursery and during the early growth stage of a plantation cannot be overemphasized (Oni and Bada, 1992). Seed grading aids a better understanding of the physiological quality of the seed lot (Dar *et al.,* 2002). Chacon *et al.* (1998) also noted that seed size is a life history trait that may affect the fitness of parent plant and the population regeneration may cause heterogeneity in the vigour and size of the seedlings (Chacon *et al.,* 1998). As a result of this fact, it becomes necessary to consider the seed size of some species before sowing in the field. The effect of seed size on germination and seedling growth have been investigated by many researchers including Gunaga and Vasudeva (2011), Saeed and Shaukat (2000), Zarein *et al.*, (2013), Mtambalika *et al.,* (2014) and Chacon *et al.,* (1998).

There are compelling reasons why research on the effect of seed size on the germination and early seedling growth of *Dennettia tripetala* is necessary. According to Missanjo *et al.* (2014), seed germination and seedling growth stages are considered very important for raising a successful plantation since germination and seedling growth are influenced by factors and are species specific. Most cultivated stands of the species exist in traditional Agroforestry systems and compound farms. The cultivation of *D. tripetala* (Pepper fruit) is typically done without the knowledge of the effects of seeds size on its germination thereby leading to low productivity or small scale production. This creates the need for germination and seedling growth studies on the species to provide essential and relevant information on the silviculture of the species. Obtaining adequate knowledge on the best seed size suitable for the germination of *Dennettia tripetala* will help to promote optimum growth and productivity. Therefore, this study was conducted to evaluate the effect of seed size on the germination and early seedling growth of *D. tripetala* (Pepper fruit) with a view to identifying the seed size with the best germination and growth potential.

Materials and Method

Study Area

This study was carried out at the research nursery of the Department of Forestry and Wildlife Management of the University of Port Harcourt, Rivers State, Nigeria. The University of Port Harcourt lies between Latitude 4.90794 and 4.90809 N and Longitude 6.92413 and 6.92432 E on a land area of about 400 hectares in Obio/Akpor Local Government Area of Rivers State (Chima *et al.,* 2017).

Collection and Processing of Seeds

Mature fruits of *Dennettia tripetala* (pepper fruit) were procured from the market. The fruits were allowed to decompose to enable easy extraction of seeds from the fruits. Seed viability test was carried out using the floatation method. The seeds that floated were regarded as non-viable and discarded while the seeds that sank were regarded as viable and used for the study.

Seed Size Determination

The diameter and length of the seeds was used to classify seeds into three size classes namely; small, medium and large. A digital caliper was used to measure the diameter and length of the seeds. The measurement of the seed length was done over the seed coat along the longest axis of the seed while seed diameter was measured on the widest faces at the middle of the seed.

Table 1: Seed size categories in terms of weight and length

Seed size categories	Range of seed diameter (mm)	Average diameter (mm)	Range of seed length (mm)	Average length (mm)
Small	4.04–5.88	5.27	9.14–11.07	10.25
Medium	6.00–7.01	6.47	11.63–12.96	12.46
Large	7.03–8.10	7.25	13.05–15.21	14.01

Experimental Design

Germination

The experiment was laid out in a completely randomized design involving 300 seeds (100 seeds for each of the three (3) seed sizes) i.e. 25 seed x 4 replicates x 3 seed sizes = 300 seeds. Seeds were sown in germination trays measuring 17cm x 13cm x 35cm, filled with sterilized sharp sand, and watered daily with 250ml of water.

Seedling growth

At the two-leaf stage, seedlings were transplanted into polybags measuring 15cm x15cm x20cm filled with sterilized forest topsoil. A total number of 60 seedlings equally divided among the three different seed sizes were used to determine the most suitable seed size for germination and early growth of *Dennettia tripetala.* Watering and weeding were carried out regularly and when required throughout the period of the experiment.

At the end of the experiment, five seedlings per treatment (seed size) were randomly selected and carefully removed from the polybags and the root system exposed by carefully washing off the growth medium from the roots. Absorbent paper was used for blotting excess moisture from the plants. The seedlings were cut into root and shoot at the root collar using a sterilized knife. The shoot and root of each seedling was weighed to determine the wet weight before placing them in a paper bag for drying. The samples were oven dried at 70°C for three days (72 hours) and later weighed to determine the moisture content of the shoot and root.

Data Collection

Germination

Observations on germination were made and recorded daily; this was terminated after sixty days. Germination emergence, duration and percentage were calculated as

Germination emergence (GE) = Number of days after sowing before plumule emergence

Germination Duration (GD) = Number of days from the first plumule emergence to the last

Germination percentage (GP) = $\frac{Total\ germinated\ seeds}{Total\ seeds\ sown} * \frac{100}{1}$

Seedling Growth

Initial shoot parameter measurements were done on all seedlings immediately after transplanting and monthly thereafter for three months. The seedling heights were measured from the substrate level to the tip of the youngest leaf using a meter rule; stem collar diameter was measured at the root collar using a veneer caliper while leaf production was determined by directly counting the number of leaves. The seedlings were weighed using a digital weighing scale calibrated in grams (g) to determine plant fresh and dry weight while moisture content was calculated using the following equation.

Moisture Content = Fresh weight – dry weight

Data Analysis

Data collected on germination and early seedling growth were analysed using SPSS statistical software (SPSS version 18, SPSS Inc.). One way analysis of variance was used to determine variation and significance of F-value at $p < 0.05$.

Results

Effect of Seed size on germination emergence, duration and percentage of *Dennettia tripetala*

Data on seed germination emergence (GE), germination duration (GD) and germination percentage (GP) of *D. tripetala* seeds of different sizes are presented in Figures 1, 2 and 3, respectively. Germination (GE) varied significantly ($p \leq 0.05$) while there were no significant differences ($p > 0.05$) in GD and GP among different seed sizes.

Germination Emergence and Duration

Germination (plumule) emergence varied from day 21 to day 24. Emergence was earliest with small seed size of *D. tripetala* followed by the medium seed size and the large seed size, respectively. Mean germination duration varied from 7.00 to 8.25. Large seed size of *D. tripetala* had the shortest germination duration, followed by the medium seed size, and the small seed size, respectively. This information on germination (plumule) emergence and duration is presented in Figure 1.

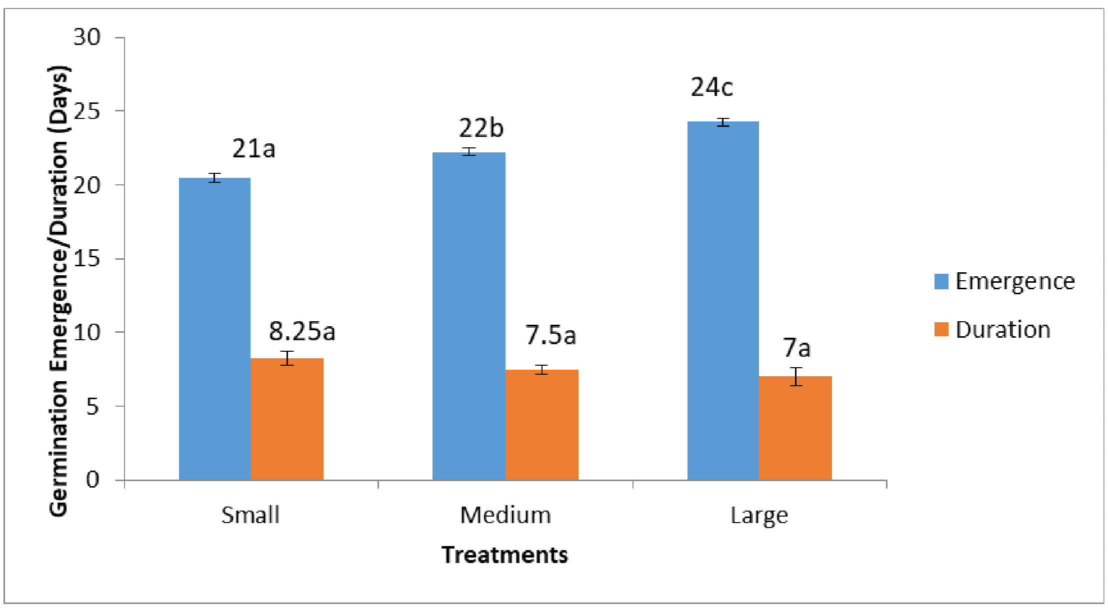

Figure 1: Effects of seed size on germination emergence and Duration of *D. tripetala*
Bars with the same letter (s) are not significantly different at the 0.05 level.

Germination Percentage

Mean germination percentage varied from 71% to 74%. Small seed size of *D. tripetala* had the highest mean germination percentage, followed by the medium seed size, and the large seed size, respectively, as shown in Figure 2.

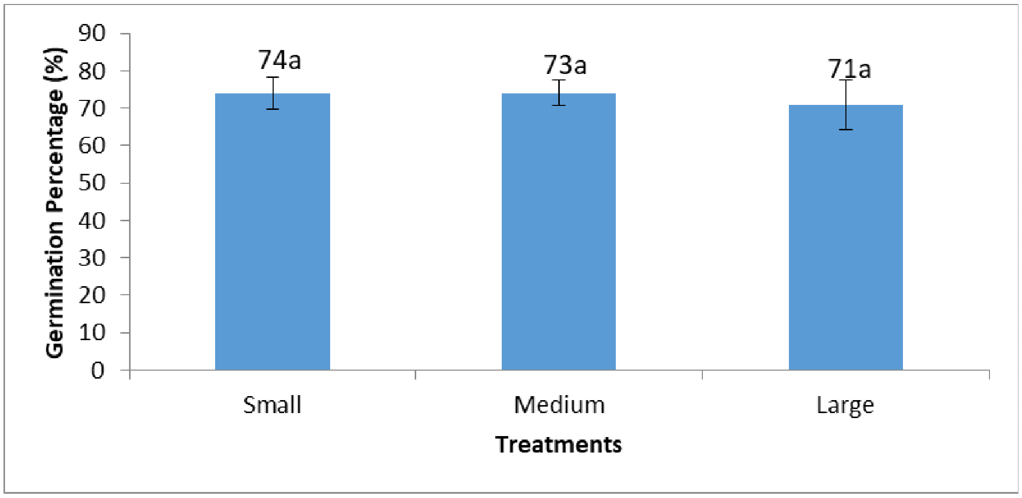

Figure 2: Effects of seed size on germination Percentage (GP) of *D. tripetala*
Bars with the same letter (s) are not significantly different at the 0.05 level.

Seedling Height

The effect of seed size (Table 2) on the height of *Denettia tripetala* seedlings was significant ($P \leq 0.05$). Highest seedling height was observed in large seed size at months 2 to 5, followed by medium seed size while lowest seedling height was observed in small seed size

Table 2: Effect of seed size on mean seedling height (cm) of *Denettia tripetala* seedlings

Treatments	HT2	HT3	HT4	HT5
Small	4.04±0.11c	4.52±0.11c	9.15±0.30c	9.44±0.29c
Medium	4. 73±0.17b	5.11±0.17b	10.30±0.47b	10.67±0.45b
Large	5.54±0.19a	5.91±0.20a	11.36±0.44a	11.88±0.40a
Mean	4.77±0.12	5.18±0.12	10.27±0.26	10.26±0.25
P-value	0.000	0.000	0.002	0.000

Means on the same column with the same alphabet are not significantly different ($p > 0.05$)
HT2 to HT5 = Mean seedling height from at Months 2 to 5

Collar Diameter

Seed size significantly ($p \leq 0.05$) affected the collar diameter of *Denettia tripetala* seedlings as shown in Table 3. Large seed size had highest collar diameter at month 2 to 5, followed by the medium seed size while the lowest collar diameter was observed in small seed size.

Table 3: Effect of seed size on mean collar diameter (mm) of *Denettia tripetala* seedlings

Treatments	CD 2	CD 3	CD 4	CD 5
Small	1.38±0.03b	1.50±0.02b	1.58±0.03b	1.76±0.03b
Medium	1.70±0.05a	1.86±0.05a	1.98±0.04a	2.16±0.07a
Large	1.76±0.05a	1.95±0.04a	2.07±0.03a	2.27±0.04a
Mean	1.62±0.03	1.77±0.03	1.88±0.03	2.06±0.04
P-value	0.000	0.000	0.000	0.000

Means on the same column with the same alphabet are not significantly different ($p > 0.05$)
CD 2 to CD 5 = Mean seedling collar diameter at months 2 to 5

Leaf Number

The effect of seed size on leaf production in *D. tripetala* is shown in Table 4. Seedlings of *D. tripetala* grown from seeds of different sizes were not significantly different ($p \leq 0.05$) in terms of their number of leaves at months 2 to5.

Table 4: Effect of seed size on mean leaf number of *Denettia tripetala* seedlings

Treatments	LF 2	LF 3	LF 4	LF 5
Small	2.00±0.00	2.70±0.611a	2.85±0.08a	2.90±2.29a
Medium	2.00±0.00	2.65±0.11a	2.75±0.10a	2.80±2.13a
Large	2.00±0.00	2.60±0.11a	2.75±0.10a	3.05±3.56a
Mean	2.00±0.00	2.65±0.06	2.78±0.05	2.92±1.71
P-value		0.811	0.687	0.172

Means on the same column with the same alphabet are not significantly different ($p > 0.05$)
LF 2 to LF5 = Mean number of leaves produced at months 2 to 5

Plant Biomass

Seedling biomass (plant biomass) of the different seed sizes is presented in Table 5. Both fresh weight and dry weight were highest in large seed size and lowest in small seed size. Also, there were significant differences in fresh and and dry weights among the different seed sizes.

Table 5: Biomass of *D. tripetala* seedlings from the different seeds sizes

Plant Biomass	Seed Size			
	Small	Medium	Large	*P value*
Fresh Weight	0.30±0.01b	0.52±0.05a	0.60±0.03a	0.000
Dry weight	0.08±0.01c	0.11±0.00b	0.13±0.00a	0.000
Moisture Content	0.22±0.01b	0.41±0.06a	0.47±0.03a	0.002

Means with the same alphabet on the same row are not significantly different ($p > 0.05$)

Discussion

Seed size regulates the germination and subsequent seedling growth in many species (Kandya, 1978). Seed sizes significantly affected germination (plumule) emergence of *Dennttia tripetala* but did not affect germination duration and percentage. According to Mtambalika *et al.* (2014) all the three seed sizes can germinate provided that the condition is optimal for germination. This concurs with the findings of Zhang and Maun (1990), Shipley and Parent (1991), Annapurna *et al.* (2005) and Alves *et al.* (2005) who reported lack of significant difference in germination percentage of *Agropyron psammophilum,* 64 wetland species, *Santalum album* and *Mimosa caesalpiniifolia* seeds of different sizes, respectively. Missanjo *et al.* (2013) also noted that seed sizes of *Albizia lebbeck* did not have any effect on the germination percentage of the species. However, these findings contradict the report of Ahirwar (2012) that germination percentage was strongly influenced by seed size in *Alangium lamarckii* seeds.

Earliest germination emergence and highest percentage observed in small seed size agrees with the findings of Stamp (1990), Lafond and Baker, (1986), Umeoka and Ogbonnaya, (2016) and Roy *et al.* (1996) who reported decreased rate of germination for large seeds in *Erodium brachycarpum,* wheat cultivars, *Telfairia occidentalis,* and rice respectively, than in small seeds. Similarly, Murali (1997) reported after observing 99 species of Western Ghats that smaller seeds germinated faster than larger seeds. Reuzeau *et al.* (1992) stated that lipid concentration was higher in small seeds with high germinability than in big seeds which were poor germinators. This study disagrees with the findings of Manonmani *et al.* (1996), Cicek and Tilki (2007), Gunaga *et al.* (2007) and Gunaga and Vasudeva (2011) who reported that larger seeds had quicker and higher germination in *Pangamia pinnata*, *Castanea sativa, Vateria indica* and *Mammea suriga* respectively, and attributed it to the presence of higher amount of carbohydrate and other nutrients than in medium and small seeds. Shortest germination duration observed in large seeds agrees with the findings of Omokhua *et al.* (2015), who observed shortest germination period in large seeds when compared to medium and small seeds. These variations in results probably indicate that differences in seed sizes may affect plant species differently in terms of seed germination (plumule emergence), duration of germination and germination percentage.

Seedling growth characteristics such as seedling height and collar diameter were significantly different among seed sizes with larger seed size having highest seedling height and collar diameter than the medium and small seed sizes. Highest height and collar diameter observed in large seed size could be due to availability of more food reserves in large seeds while the lowest growth observed in small seed size could be attributed to relatively lower food reserve in the small sized seeds (Owoh *et al.,* 2011). This result agrees with that of Oni and Bada (1992), Owoh *et al.* (2011) and Mtambalika *et al*. (2014) who observed highest growth in large seeds compared to medium and small seed sizes in *Terminalia irvorensis*, *Gmelina arborea* and *Afzelia quanzensis* respectively. Boot (1996) also reported that bigger seeds usually produce bigger seedlings with larger area of green leaves capable of conducting photosynthesis. Similarly, Wulff (1986) and Bower (2004) reported that large seeds produce large seedlings. It was observed that seedlings of *D. tripetala* grown from seeds of different sizes showed no significant differences in their number of leaves. This is in line with the report of Gunaga and Vasudeva (2011) who stated that number of leaves per seedling did not show significant variation among 3 classes of seed sizes in *Mammea suriga*.

Significant differences in biomass among seed sizes and highest biomass observed in large seed size is in agreement with that of Owoh *et al.* (2011) who also observed significant differences and highest biomass in large seed size followed by medium seed size and lowest in small seed size. Also Chacon *et al.* (1998) reported that the biomass of root, shoot and leaves were greater in large seeds of *Cryptocarya alba*. According to Zareian *et al.* (2013), higher seedling dry weight observed in larger seeds sizes are related to more seed food storages in their endosperms. On a general note, the growth of *D. tripetala,* as observed in this study was slow and poor. Although, Osaigbovo *et al.* (2010) reported that *D. tripetala* exhibits inconsistent poor germination and slow seedlings growth, the germination rate (percentage) for the three seed size classes was appreciably high.

Conclusion

This study has shown that seed size is very important in the germination and early seedling growth of *D. tripetala*. The result from this study has provided some basic information on germination and early seedling growth characteristics of *D. tripetala*. Although small seeds germinated faster than medium and large seed sizes, large seeds exhibited the highest growth with respect to height, collar diameter and biomass when compared with the small and medium seeds. Therefore foresters and farmers interested in cultivating *D. tripetala* are advised to use large seeds for better growth.

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